

# TERTIARY MOLLUSKS OF THE GENUS ORTHAULAX FROM THE REPUBLIC OF HAITI, PORTO RICO, AND CUBA.

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A large number of Tertiary mollusks were collected during a geologic reconnaissance of the Republic of Haiti, under the supervision of the United States Geological Survey, by J. S. Brown, W. S. Burbank, and myself during the winter of 1920-21. The largest collections are from beds of Miocene age in the Central Plain, an interior plain in the northern part of the Republic, where a moluscan fauna of more than 300 species was obtained from the Thomonde formation. A preliminary account of the stratigraphy of the Miocene rocks of the Central Plain has been published,<sup>1</sup> and a detailed description of the rocks with faunal lists is now ready for press.<sup>2</sup>

Most of the Miocene mollusks are undescribed, and as a long interval of time may elapse before they are monographed it is planned to give accounts of the most interesting species.

*Orthaulax aguadillensis* Maury is the most striking and one of the commonest of the mollusks in the upper faunal zone of the Thomonde formation. In the Republic of Haiti it is confined to this faunal zone, which embraces the uppermost 100 meters of the Thomonde formation, and it was collected at every locality where collections were made from this zone.

During February, 1922, G. R. Mansfield, of the United States Geological Survey, while examining a dam site for the Porto Rican Government in the Province of Aguadilla, collected an interesting new species of *Orthaulax* from beds probably of middle Oligocene age on Rio Guajataca. This species is described to supplement Cooke's recent summary of all the known species of the genus.<sup>3</sup> Mr. Mansfield also collected casts of *Orthaulax aguadillensis* Maury from the Quebradillas limestone at the locality given on page 8.

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<sup>1</sup> Woodring, W. P., Stratigraphy, structure, and possible oil resources of the Miocene rocks of the Central Plain: Rep. Haiti Geol. Survey, 19 pp., map, 1922.

<sup>2</sup> Woodring, W. P., J. S. Brown, and W. S. Burbank, Geology of the Republic of Haiti: Rep. Haiti Geol. Survey (ready for press).

<sup>3</sup> Cooke, C. W., *Orthaulax*, a Tertiary guide fossil: U. S. Geol. Survey Prof. Paper 129-B, pp. 23-31, pls. 2-5, 1921.

Geologists of the South American Gulf Oil Co. recently deposited in the United States National Museum collections of Tertiary fossils from the Province of Piñar del Rio, Republic of Cuba. A collection from the Consolacion limestone at a locality 5.6 kilometers north-east of San Cristobal (U.S.G.S. station 1/186) contains the small specimen of *Orthaulax aguadillensis* Maury figured on Plate 2, Figure 4. The rock in the body cavity of this specimen contains nests of *Miogypsina antillea* (Cushman). Small shells and casts of *Orthaulax caepa* Cooke were obtained in the same region and from the same limestone at the following localities: upper Oligocene, Consolacion limestone 8 kilometers west of Taco-Taco, W. Gretzinger collector, four specimens, U.S.G.S. station 1/181; Consolacion del Sur, W. Gretzinger, collector, five specimens (casts, identification doubtful), U.S.G.S. station 1/183.

Wythe Cooke, of the United States Geological Survey, has recently identified a specimen of *Orthaulax gabbi* Dall collected by Bruce Wade, of the Transcontinental Oil Co., at the Topila Hills, 25 kilometers southwest of Tampico, Vera Cruz, Mexico. Mr. Cooke has kindly given the following heretofore unpublished records of *Orthaulax pugnax* (Heilprin): U.S.G.S. station 1/103, Glendon limestone, sec. 25, T. 4 N., R. 20 E., on road to Elba, 1.1 kilometers, north of Goodman, Coffee County, Alabama, W. Cooke, and J. Gardner, collectors, May 12, 1921; U.S.G.S. station 1/104, Glendon limestone, Holmes County, Florida, 0.8 kilometer south of the State line on road from Geneva, Alabama, to Westville, Florida, W. Cooke and J. Gardner, collectors, June 9, 1921; U.S.G.S. station 1/106, Glendon limestone, 3.8 kilometers from Geneva, Ala., on road to Vaughanville, Alabama, W. Cooke and J. Gardner, collectors, May 10, 1921. The faunal associates of *Orthaulax pugnax* at these localities and their stratigraphic significance are given by Cooke in a paper awaiting publication by the United States Geological Survey. Dr. C. A. Matley, Government geologist of Jamaica, has recently collected *Orthaulax pugnax* from beds of middle Oligocene age near Jackson Town, Jamaica; and *Orthaulax aguadillensis* from beds of lower Miocene age near May Pen, Jamaica.

The preceding records bring up to date all the known localities for the genus.

#### THE GENUS ORTHAULAX.

*Orthaulax* is a peculiar stromboid mollusk found only in the tropical and subtropical faunas of middle Oligocene (Rupelian), upper Oligocene (Aquitanian), and lower Miocene (Burdigalian) age in the West Indies, Central America, Mexico, and southeastern United States. The genus thus has a restricted stratigraphic and geographic range. It was described by Gabb in 1872.<sup>4</sup> The genotype is *O. in-*

<sup>4</sup> Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 272, 1872.

*ornatus* Gabb,<sup>5</sup> collected by Gabb at an unknown locality in the Dominican Republic. The age of the beds from which this species came was not known until 1919, when D. D. Condit, then of the United States Geological Survey, during a geologic reconnaissance of the Dominican Republic under the direction of T. W. Vaughan, collected it from the Baitoa formation at the type locality of the formation on Rio Yaque del Norte at Baitoa. The known Baitoa molluscan fauna numbers about 60 species and is clearly of lower Miocene (Burdigalian) age.<sup>6</sup> The type of *O. inornatus* has recently been redescribed by Pilsbry.<sup>7</sup>

The genotype was discovered also in beds of upper Oligocene age in Florida.<sup>8</sup> The following four additional species have been described: *O. pugnax* (Heilprin) from beds of middle Oligocene age in Georgia<sup>9</sup> and the island of Antigua,<sup>10</sup> and from beds of upper Oligocene age in Florida;<sup>11</sup> *O. gabbii* Dall, from beds of upper Oligocene age in the Panama Canal Zone,<sup>12</sup> and from beds of lower Miocene age in Florida<sup>13</sup> and Porto Rico<sup>14</sup> (identification doubtful); *O. aguadillensis* Maury, from beds of upper Oligocene age in Porto Rico,<sup>15</sup> Anguilla<sup>16</sup> (identification doubtful), St. Croix,<sup>17</sup> and the Dominican Republic,<sup>18</sup> and from beds of lower Miocene age in the

<sup>5</sup> Acad. Nat. Sci. Philadelphia, Proc., vol. 24, p. 272, pl. 9, figs. 3, 4, 1872.

<sup>6</sup> See Vaughan, T. W., and W. P. Woodring, Chap. 4, Tertiary and Quaternary stratigraphic paleontology: A geological reconnaissance of the Dominion Republic. Dominican Rep. Geol. Survey Mem., vol. 1, p. 96, 1921.

<sup>7</sup> Pilsbry, H. A., Acad. Nat. Sci. Philadelphia Proc., vol. 73, p. 368, pl. 30, figs. 13-15, 1922.

<sup>8</sup> Dall, W. H., U. S. Nat. Mus. Bull. 90, p. 86, pl. 11, fig. 4, 1915; Dall, W. H., U. S. Nat. Mus. Proc., vol. 51, p. 509, pl. 88, fig. 9, 1916; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 28, pl. 2, fig. 4, 1921.

<sup>9</sup> Dall, W. H., U. S. Nat. Mus. Proc., vol. 51, p. 509, 1916 (also as *O. inornatus* on same page); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 29, pl. 3, fig. 2, 1921.

See p. 2 for hitherto unpublished localities in Alabama and Florida.

<sup>10</sup> Cooke, C. W., Carnegie Inst. Washington Pub. 291, p. 115, pl. 2, fig. 4, 1919; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 29, pl. 3, figs. 3a, 3b, 1921.

<sup>11</sup> Heilprin, A., Wagner Free Inst. Sci. Trans., vol. 1, p. 107, pl. 15, figs. 36, 36a, 1887; Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, p. 170, pl. 8, figs. 5, 8, 1890. Dall, W. H., U. S. Nat. Mus. Bull. 90, p. 87, pl. 15, figs. 5, 10, 1915; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 29, pl. 3, figs. 1a, 1b, 4a, 4b, 1921.

<sup>12</sup> Cooke, C. W., in T. W. Vaughan, U. S. Nat. Mus. Bull. 103, p. 550, 1919 (as *O. pugnax*); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 30, 1921.

<sup>13</sup> Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, p. 170, pl. 12, figs. 5, 5a, 5b, 1890; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 30, pl. 3, figs. 5-7; pl. 4, fig. 1, 1921.

<sup>14</sup> Hubbard, B., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 2, p. 145, pl. 23, fig. 3, New York Acad. Sci., 1921.

<sup>15</sup> Maury, C. J., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 1, p. 58, pl. 9, fig. 4, New York Acad. Sci., 1920; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, fig. 2, 1921.

<sup>16</sup> Cooke, C. W., Carnegie Inst. Washington Pub. 291, p. 115, pl. 2, fig. 3, 1919 (as *O. pugnax*); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, fig. 3, 1921.

<sup>17</sup> Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, fig. 4, 1921.

<sup>18</sup> Idem.

Dominican Republic<sup>19</sup>; and *O. caepa* Cooke from beds of upper Oligocene age in Cuba.<sup>20</sup> Cooke has fully described and figured the preceding five species. Hubbard<sup>21</sup> has described as *O. portoricensis* casts that seem to be *O. aguadillensis* from beds of lower Miocene age in Porto Rico and Vieques. Pilsbry<sup>22</sup> has recently described as *O. inornatus altilis* some of Gabb's specimens from the Dominican Republic that have a shorter spire than the type of *O. inornatus*. In view of the greater difference in outline of other species the separation of this subspecies is hardly warranted. *O. conoides* Woodring, collected from beds probably of middle Oligocene age in Porto Rico, completes the list of the six species that are here considered valid. All the species except *O. caepa* Cooke and *O. conoides* Woodring seem to have a stratigraphic range embracing two stages.

## Family STROMBIDAE.

### Genus ORTHAULAX Gabb.

*Orthaulax* GABB, Acad. Nat. Sci. Philadelphia, Proc., vol. 24, p. 272, 1872.

Type (by monotypy): *Orthaulax inornatus* Gabb, Acad. Nat. Sci. Philadelphia, Proc., vol. 24, p. 272, pl. 9, figs. 3, 4, 1872. Lower Miocene, Dominican Republic.

The following is a description of the genus:

Shell attaining a large size, fusiform, conical or ovate; cross section triangular or circular; early whorls bearing varices, entirely concealed in adult shells; after 7 to 10 volutions, outer lip extending to tip of spire and in each succeeding volution completely enveloping spire; space between spire and each enveloping whorl filled with callus; later whorls smooth, or sculptured with narrow spiral threads on and below the shoulder; aperture elliptical, gradually constricted posteriorly into a narrow channel ascending the spire; outer lip thin except at posterior end of aperture, expanded, bearing near the base a very shallow sinus; siphonal notch at base of aperture wide and very deep; anterior fasciole swollen; base of columella slender, curved backward, undercut by siphonal notch; columellar callus thickened at base of posterior channel, thinner over inner lip and extending to base of columella; base of body whorl of young shells sculptured with spiral sulci that widen toward the base.

<sup>19</sup> Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, figs. 5, 6: pl. 5, figs. 1a, 1b, 1921.

See pp. 7, 8 for additional localities in the Republic of Haiti and Cuba.

<sup>20</sup> Cooke, C. W., Carnegie Inst. Washington Pub. 291, p. 116, pl. 2, figs. 1, 2, 1919 (as *O. inornatus*); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 5, figs. 2a, 3b, 1921.

See p. 2 for additional localities in Cuba.

<sup>21</sup> Hubbard, B., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 2, p. 146, pl. 25, figs. 1-5, New York Acad. Sci., 1921.

<sup>22</sup> Pilsbry, H. A., Acad. Nat. Sci. Philadelphia Proc., vol. 73, p. 369, pl. 30, figs. 16-18, 1922.



The specimen of *O. gabbi* figured by Dall<sup>23</sup> (U.S.N.M. Cat. No. 112218) is the only known specimen of the genus that shows all the features of the aperture of a shell after the spire is covered. The backward curving of the slender base of the columella gives *Orthaulax* a characteristic stromboid appearance. The sinus near the base of the outer lip, a characteristic feature of *Strombus* and other genera of the family, is very shallow in *Orthaulax*. Most of the specimens of *O. gabbi* and *O. pugnax* have three thickened subsutural columellar calluses on the later whorls, and as they are not absorbed, they produce the triangular cross section of these species when concealed by growth. On a few specimens of *O. gabbi* the callus is thin, producing a subcircular cross section. The type of *O. inornatus* has a concealed thickened callus about 40° in a clockwise direction from the callus at the aperture, producing a dorso-ventral compression, but most of the specimens of this species apparently have a thin callus, or the callus is absorbed, as their cross section is circular. As specimens of *O. aguadillensis* of different growth stages have a thick subsutural callus at the aperture, it is inferred that the callus is absorbed in this species, which has a circular cross section. The columellar callus of *O. caepta* and *O. conoides*, both of which have a circular outline, is not known.

#### ORTHAULAX AGUADILLENSIS Maury.

Plate 1; Plate 2, figs. 3-6.

*Orthaulax pugnax* COOKE (part), 1919, Carnegie Inst. Washington Pub. 291, p. 115, pl. 2, fig. 3.

*Orthaulax aguadillensis* MAURY, 1920, Scientific survey of Porto Rico and the Virgin Islands, vol. 3, pt. 1, p. 58, pl. 9, fig. 4, New York Acad. Sci.

*Orthaulax portoricensis* HUBBARD, 1921, Scientific survey of Porto Rico and the Virgin Islands, vol. 3, pt. 2, p. 146, pl. 25, figs. 1-5, New York Acad. Sci.

*Orthaulax aguadillensis* Maury, COOKE, 1921, U. S. Geol. Survey Prof. Paper 129-B, p. 30, pl. 4, figs. 2-6; pl. 5, figs. 1a, 1b.

The following is the original description:

Shell large and heavy, form of spire short and blunt, like that of *Orthaulax pugnax*. This at once distinguishes the shell from the Dominican species, *O. inornatus* Gabb, which is high-spined. A further characteristic of the shell is the evenly rounded form of the shoulder, which in cross section would be almost perfectly circular. This marks it off very decisively from the Floridian, Chipolan species, *Orthaulax gabbi* Dall, which is markedly triangular at the shoulder. The spire measures 45 mm. in diameter.

*Type locality*.—Aguadilla, station 3, Porto Rico.

*Type*.—American Museum of Natural History.

The following is a description of specimens from the Republic of Haiti:

<sup>23</sup> Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pl. 12, figs. 5a, 5b, 1890.

Shell attaining a large size, heavy, ovate in outline, circular in cross section; apex conical or hemispherical, apical angle  $85^{\circ}$  to  $115^{\circ}$ ; early whorls bearing an indeterminate number of low swollen varices (see pl. 2, figs. 3, 5); spire concealed at about beginning of seventh whorl; callus between succeeding whorls, as shown in axial section, thick at and below shoulder, rapidly thinning above shoulder; inner lip bearing a heavy subsutural callus; outer lip greatly thickened opposite this callus; channel between callus and thickened outer lip very narrow and deep on body whorl, filled with callus on earlier whorls; later whorls sculptured on and below shoulder with narrow, closely spaced spiral threads; base of body of young shells sculptured with narrow spiral grooves; base of outer lip and base of columella of adult shell not known.

The dimensions in millimeters of the most perfect specimens from the Republic of Haiti are as follows:

Height.	Diameter.
155	95 (pl. 1, fig. 9)
150	110
145	90
115	64
55	40 (cast, pl. 1, fig. 1)
28	15 (pl. 2, fig. 3)

The circular cross section, the shape of the whorls, of the callus between the whorls, and of the body cavity, as shown by axial sections, are the most characteristic features of *O. aquadillensis*. Cooke's method of studying axial sections is particularly useful in determining features of this species. The heavy subsutural callus and thickened outer lip are striking features. (See pl. 1, figs. 5, 8.) The deep narrow channel between them resembles the similar channel on *Strombus lacinatus* Chemnitz, *Strombus latissimus* Linnaeus, and other Indo-Pacific strombs that have the outer lip extending far up the spire. This deep channel is shown in casts by the sharp upper edge of the cast of the body whorl. The upper edge of casts of the whorls of the spire are progressively blunter toward the apex. As casts of different size show these features, and as shells of different size have the heavy subsutural callus, the deep channel at the posterior end of the body cavity is filled up as the animal withdraws during growth and the subsutural callus is absorbed. The filling of the channel by callus is shown in axial sections of the shell. The open space in the axial sections and the corresponding parts filled with sediment shown on Plate 1, Figures 3, 4, 10, 11, correspond to the casts (pl. 1, figs. 1, 6, 7). The range in outline of the shell is shown by Plate 1, Figures 4, 10, which represent two worn specimens from the same locality. As Cooke observed a similar difference in

outline of specimens of *O. aguadillensis* from the Dominican Republic and of *O. caepa* from Cuba, he suggested that the difference may be a sexual feature, although a similar sexual difference is not known in the living species of *Strombus*. The spiral threads are most conspicuous on medium-sized shells. (See pl. 2, fig. 6.) They are as prominent as on *O. caepa*, but are more closely spaced. The layers of shell and callus covering the spire have undulating growth lines similar to those shown in an exaggerated fashion on Maury's figure. (See pl. 1, fig. 1.)

*Orthaulax aguadillensis* was described by Maury from a single imperfect specimen collected in Porto Rico from the Aguadilla limestone, which is considered of upper Oligocene age. It seems to be very common as casts in the overlying Quebradillas limestone, which is of lower Miocene age. Hubbard called these casts *O. portoricensis*. A Porto Rican cast (pl. 1, fig. 7), collected at the cut just west of Rio Guajataca on the railroad from Quebradillas to Isabella by G. R. Mansfield (U.S.G.S. station 1/146), is introduced for comparison with casts from the Republic of Haiti (pl. 1, figs. 1, 6). The cast shown on Plate 1, Figure 6, was collected at a locality where shells were obtained. One specimen from this locality that has part of the shell dissolved revealing the cast conclusively shows that these casts from the Republic of Haiti are *O. aguadillensis*.

All the specimens from the Republic of Haiti were collected from the upper faunal zone of the Thomonde formation, which is the equivalent of the Baitoa formation of the Dominican Republic, and is of lower Miocene age. The Haitian specimens duplicate those collected on Rio Yaque del Sur, Dominican Republic, from beds of lower Miocene age.

The following is a list of the localities in the Republic of Haiti, all of which are in the southeastern part of the Central Plain in the Arrondissements of Las Cahobas and Hinche:

Crest of Thomonde anticline, left bank of Rivière Thomonde, about 4 kilometers east-southeast of Thomonde, W. P. Woodring and F. G. Evans, jr., collectors, 1921, five specimens, U.S.G.S. station 9782. North limb of Thomonde anticline, about 2.5 kilometers east-northeast of Thomonde on trail to Thomassique, W. P. Woodring and F. G. Evans, jr., collectors, 1921, two specimens, U.S.G.S. station 9780. North limb of Thomonde anticline, about 2.8 kilometers east-northeast of Thomonde, W. P. Woodring and F. G. Evans, jr., collectors, 1921, two specimens, U.S.G.S. station 9781. North limb of Thomonde anticline, about 4 kilometers north-northwest of Thomonde on trail to Hinche, W. P. Woodring and F. G. Evans, jr., collectors, 1921, one specimen (cast), U.S.G.S. station 9929. South limb of Thomonde anticline, about 1.3 kilometers south-southeast of

Thomonde on trail to Las Cahobas, W. P. Woodring and F. G. Evans, jr., collectors, 1921, 15 specimens, U.S.G.S. station 9779. South limb of Thomonde anticline, about 1.5 kilometers south-southeast of Thomonde on trail to Las Cahobas, W. P. Woodring and F. G. Evans, jr., collectors, 1921, one specimen (cast), U.S.G.S. station 9778. Left bank of Ravine Roche Salée at crossing of trail from Hinche to Thomassique about 6 kilometers southeast of Los Palos, W. P. Woodring and F. G. Evans, jr., collectors, 1921, three specimens, U.S.G.S. station 9945. Same locality as station 9945, but on right bank of stream and from beds about a meter higher stratigraphically, one specimen, U.S.G.S. station 9946. Trail from Thomassique to Cercala-Source, about 0.5 kilometer north-northeast of Thomassique, W. P. Woodring and F. G. Evans, jr., collectors, 1921, 18 specimens, U.S.G.S. station 9947.

Other localities are as follows:

Upper Oligocene, Anguilla formation, southwest shore of Crocus Bay, Anguilla, T. W. Vaughan, collector, 1914, one specimen (identification doubtful), U.S.G.S. station 6965. Upper Oligocene, Montpellier East, St. Croix, J. T. Quin, collector, two specimens (casts), U.S.G.S. station 8650. Upper Oligocene, Cevicos limestone, east side of Arroyo Blanco, east of Loma de Los Palos, on road from Cotui to Cevicos, Dominican Republic, C. W. Cooke and C. P. Ross, collectors, 1919, six specimens, U.S.G.S. station 8598. Upper Oligocene, Aguadilla limestone, Aguadilla station 3, Porto Rico, C. A. Reeds, collector, one specimen (type), expedition of New York Academy of Sciences, the Porto Rican Government and the American Museum of Natural History cooperating. Upper Oligocene, Consolacion limestone, 5.6 kilometers northeast of San Cristobal, Province of Piñar del Rio, Republic of Cuba, W. Gretzinger, collector, 1922, one specimen, U.S.G.S. station 1/186. Upper Oligocene, Consolacion limestone, 7.2 kilometers south of San Diego de los Banos, Province of Piñar del Rio, Republic of Cuba, W. Gretzinger, collector, 1922, two specimens (casts, identification doubtful), U.S.G.S. station 1/182. Lower Miocene, Quebradillas limestone, stations 204, 41, 52(a), 801, and "numerous other localities not recorded," Porto Rico ("*O. portoricoensis*"), expedition of New York Academy of Sciences, the Porto Rican Government and the American Museum of Natural History cooperating. Lower Miocene (?), east coast of Vieques Island, A. K. Lobeck, collector, one specimen, expedition of New York Academy of Sciences, the Porto Rican Government and the American Museum of Natural History cooperating. Lower Miocene, cut on railroad from Quebradillas to Isabella, just west of Rio Guajataca, Porto Rico, G. R. Mansfield, collector, 1922, 18 species (casts, "*O. portoricoensis*") U.S.G.S. station 1/146. Lower Miocene, left bank



of Rio Yaque del Sur at upper edge of Los Güiros, Dominican Republic, D. D. Condit, collector, 1919, five specimens, U.S.G.S. station 8572. Lower Miocene, west bank of Rio Yaque del Sur opposite Palo Copado, Dominican Republic, D. D. Condit, collector, 1919, one specimen, U.S.G.S. station 8590. Lower Miocene, trail from Azua to Cabral, about 10 kilometers west of crossing of Rio Tábara, Dominican Republic, N. H. Darton, collector, 1920, one specimen, U.S.G.S. station 8760.

**ORTHAULAX CONOIDES, new species.**

Plate 2, figs. 1, 2, 7.

Shell medium sized, conical, spire low, the enveloping whorls bent almost at an angle of  $90^\circ$  at the shoulder; cross section circular; callus between the whorls lenticular below the shoulder, abruptly thinning above the shoulder and continuing as a very thin wedge to the apex of the shell; upper edge of body cavity angular on later whorls, more rounded on early whorls; aperture not known.

The dimensions in millimeters are given in the following table:

Height.	Diameter.
45+	53 (type, pl. 2, figs. 2, 7)
53+	47 (pl. 2, fig. 1)
52+	47
25+	43

*Type*.—Cat. No. 328395, U.S.N.M.

*Type locality*.—U.S.G.S. station 1/139, Porto Rico, Province of Aguadilla, pit No. 5, on right side of Rio Guajataca at dam site, from upper and harder layers of "lower limestone," altitude about 192 meters above sea level, G. R. Mansfield, collector, February 8, 1922, type and eight other specimens, four of which are casts.

The remarkable conical outline of the shell separates this species from all the described species of *Orthaulax*. A large specimen of *O. gabbi* in the collections of the United States National Museum from Alum Bluff, Florida (U.S.G.S. station 2211), has an unusually low spire and abruptly angulated shoulder, simulating the outline of *O. conoides*. The callus of *O. conoides* is more evenly lenticular below the shoulder than in *O. gabbi*, resembling *O. aquadillensis*, from which it differs in the abrupt constriction above the shoulder. As the body cavities of *O. conoides* and *O. aquadillensis* are similar, casts of the two species are virtually indistinguishable, although *O. conoides* does not reach the large size of *O. aquadillensis*. All the specimens of *O. conoides* are imperfect. They were embedded in limestone, but the shell and callus are preserved or faithfully replaced by calcite.

## STRATIGRAPHIC SIGNIFICANCE OF ORTHAULAX CONOIDES.

The specimens of *Orthaulax conoides* were obtained from a soft clayey limestone that crops out in the area to be flooded by the proposed dam on Rio Guajataca. Borings at the dam site show that sandy and lignitic beds underlie this limestone. The sandy and lignitic beds are about 150 meters below the bed where the specimens of *Orthaulax* were collected. They resemble the rocks called "San Sebastian," "Lares," and "Collazo shales" by different members of the New York Academy of Sciences Scientific Survey of Porto Rico and the Virgin Islands. These rocks are at the base of the Tertiary section in the northwestern part of Porto Rico. As there is no other field evidence indicating such beds at a higher horizon, Mansfield believes that they are near the surface on the crest of an unsuspected low anticlinal arch trending almost westward.

Vaughan<sup>24</sup> has recently corroborated Maury's<sup>25</sup> correlation of the "San Sebastian," "Lares," and "Collazo shales" of the north side of the island, and the "Guanica shaly limestone" of the south side, with the middle Oligocene (Rupelian) Antigua formation of the island of Antigua.

The beds containing *Orthaulax conoides* are either an offshore phase of the upper part of these beds or are the equivalent of the overlying "Lares limestone," and are therefore considered of middle Oligocene age.

Evidence derived from other fossils is not very convincing. The following additional mollusks were collected at the type locality of *Orthaulax conoides*, station 1/139. Most of them are represented by casts or impressions.

*Scaphander* ? species.

*Turritella*, species.

*Crepidula* ? species.

*Arca*, species.

*Barbatia*, species.

*Chlamys* (*Aequipecten*), two species.

*Lima*, species.

*Echinochama* ? species.

*Cardium* (*Trachycardium*), species.

*Teredo* tubes.

A coral from the same locality seems to be the same as a coral collected by Hill at a locality 6.4 kilometers west of Lares, Porto Rico (U.S.G.S. station 3191), and identified by Vaughan as *Cyathomorpha antiguensis* (Duncan) Vaughan variety. The coral from station 1/139 is so poorly preserved, however, that positive identification has not yet been practicable.

<sup>24</sup> Vaughan, T. W., Carnegie Inst. Washington Pub. 306, p. 118, 1921.

<sup>25</sup> Maury, C. J., New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 1, table opposite p. 4, New York Acad. Sci., 1920.

An apparently new species of the foraminiferal genus *Sorites* that has a larger early spiral stage than the upper Oligocene and lower Miocene species *S. americana* (Cushman) was collected at the same locality (station 1/139).

The following fossils were collected from lower beds in the same series at station 1/138, pit No. 4, on the right side of Rio Guajataka at the dam site, at an altitude of about 174 meters above sea level.

## CORAL.

*Cyathomorpha antiguensis* (Duncan) Vaughan variety.

## MOLLUSCA.

*Chlamys* (*Aequipecten*), two species.

*Chlamys* (*Plagioctenium*), species.

*Spondylus*, species.

*Ostrea*, species.

*Cardium* (*Trachycardium*), species.

*Teredo* tubes were collected at station 1/137 from the upper part of this series of beds on the right side of Rio Guajataka at the dam site, the altitude being about 208 meters above sea level.

## EXPLANATION OF PLATES.

## PLATE 1.

All figures one-half natural size.

*Orthaulax aguadillensis* Maury.

- FIG. 1.—Cast. Near Thomonde, Republic of Haiti, U.S.G.S. station 9778. Cat. No. 328388, U.S.N.M.
- 2.—Apical view of large specimen showing spiral threads on shoulder and curved growth lines. Near Thomassique, Republic of Haiti, U.S.G.S. station 9945. Cat. No. 328382, U.S.N.M.
- 3.—Axial section of specimen that has an almost perfect spire showing the completely enveloping whorls (dark) and the callus between them (light). Near Thomonde, Republic of Haiti, U.S.G.S. station 9782. Cat. No. 328385, U.S.N.M.
- 4.—Axial section of worn specimen. Near Thomonde, Republic of Haiti, U.S.G.S. station 9779. Cat. No. 328389, U.S.N.M.
- 5.—Side view of worn specimen showing thickened outer lip. Thomassique, Republic of Haiti, U.S.G.S. station 9947. Cat. No. 328383, U.S.N.M.
- 6.—Cast. Thomassique, Republic of Haiti, U.S.G.S. station 9947. Cat. No. 328387, U.S.N.M.
- 7.—Cast. Near Quebradillas, Porto Rico, U.S.G.S. station 1/146. Cat. No. 328393, U.S.N.M. Casts from the Quebradillas limestone of Porto Rico were called *O. portoricensis* by Hubbard.
- 8.—Apertural view of specimen shown in fig. 2, showing thick columellar callus, thickened outer lip, and the deep channel between them.
- 9.—Large worn specimen. Near Thomonde, Republic of Haiti, U.S.G.S. station 9779. Cat. No. 328381 U.S.N.M.

FIG. 10.—Axial section of specimen from same locality as specimen shown in Fig.

4. Cat. No. 328390, U.S.N.M.

11.—Axial section of large specimen. Near Thomonde, Republic of Haiti, U.S.G.S. station 9782. Cat. No. 328384, U.S.N.M.

#### PLATE 2.

All figures natural size.

FIG. 1.—*Orthaulax conoides* Woodring. Axial section. Rio Guajataca, Porto Rico, U.S.G.S. station 1/139. Cat. No. 328396, U.S.N.M.

2.—*Orthaulax conoides* Woodring. Axial section of type. Same locality. Cat. No. 328395, U.S.N.M.

3.—*Orthaulax aguadillensis* Maury. Apertural view of small specimen. In the last volution the whorl reaches the tip of the spire. Near Thomonde, Republic of Haiti, U.S.G.S. station 9782. Cat. No. 328391, U.S.N.M.

4.—*Orthaulax aguadillensis* Maury. Axial section. San Cristobal, Cuba, U.S.G.S. station 1/186. Cat. No. 328394, U.S.N.M. The rock in the cavity of this specimen contains nests of *Miogypsina antillea* (Cushman).

5.—*Orthaulax aguadillensis* Maury. Dorsal view of small specimen. Near Thomassique, Republic of Haiti, U.S.G.S. station 9946. Cat. No. 328392, U.S.N.M. The enveloping whorl is broken away, revealing the varices on the early whorls.

6.—*Orthaulax aguadillensis* Maury. Dorsal view showing spiral threads. Thomassique, Republic of Haiti, U.S.G.S. station 9947. Cat. No. 328386, U.S.N.M.

7.—*Orthaulax conoides* Woodring. Dorsal view of type. Rio Guajataca, Porto Rico, U.S.G.S. station 1/139. Cat. No. 328395, U.S.N.M.